EXISTING STUDIES ON RENEWABLE ENERGY AND ENERGY EFFICIENCY: A REVIEW ON LITERATURE

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ABSTRACT

The environmental impacts of energy supply are growing and becoming dominant contributors to local, regional, and global environmental problems. Besides that, the socio-political risks of energy supply are also growing. Meant for these problems, people are beginning to turn to alternative energy sources to reduce pollution while meeting their energy needs. However, to what extent these issues has been studied is persist indistinguishable. Therefore, this study attempts to provide more information on the issues of energy efficiency and renewable energy. The purpose of the study is to identify and highlight the breaches in the subject matter. The study was implemented by reviewing, summarizing and examining the approach from the numerous previous studies on energy efficiency and renewable energy. The data is based on the literatures on energy efficiency and renewable energy which can be access via Emerald Insight website.

Keywords: Energy Efficiency, Renewable Energy, Data from Previous Studies.

INTRODUCTION

Energy is one of the most basic parts of our daily life. Most of us know energy as electricity or electrical flow. But energy is actually the thing that creates electricity and then it is converted to electricity. Presently, we are entirely dependent on an abundant and uninterrupted provision of energy for living and working (International Gas Union, 2010). It is difficult to give a comprehensive definition of energy because there have many types of energy, but energy is usually defined as the ability to perform work. According to Chadwick (2012), energy also known as a property of objects which can be transferred to other objects or converted into different forms, but cannot be created or destroyed. Energy comes in two basic forms which are potential energy which is any type of stored energy (included gravitational, chemical, nuclear and elastic) and kinetic energy is found in the movement (included motion, thermal and temperature, electrical, and magnetic). According to Sarah (2013), the importance of energy, including power our homes, drive our cars, use technology such as internet, all phone systems, every appliance, air conditioning and heating, even to feed and clothe us.

The very first energy source was the sun providing heat and light during the day. Later fire was discovered by a lightning strike. Thousands of years later they discovered that the wind could be harnessed and they began to use sails on their boats for transportation. Later they began to use windmills to turn water wheels for grinding grain. Before 1850, wood was their main source of fuel for heating, cooking and producing steam for powering steam engines for the railroads. In 500 BC, the Chinese found natural gas leaking from the ground and use

bamboo to pipe the gas for use in boiling sea water to remove the salt. From about 1850 to 1945, coal was the main fuel source. Wood was still an important energy source for heating as well as natural gas for lighting, but water and wind were used less. For most of the 1900s, oil and natural gas were their main fuel sources. Electricity was used more in the late 1900s. From about 1945 to the present, nuclear and solar energy along with water and wind have played a larger role in the production of energy. Other alternative energy sources being used today are geothermal and biomass (APOGEETM Interactive, Inc., 2009).

PROBLEM STATEMENT

The energy problem today combines several conditions such as the monetary costs of energy are rising nearly everywhere; much of the world's population has too little energy to meet basic human needs; the environmental impacts of energy supply are growing and already dominant contributors to local, regional, and global environmental problems such as water pollution, air pollution, ocean pollution, and climate change; and the socio political risks of energy supply (above all the danger of conflict over oil and the links between nuclear energy and nuclear weapons) are growing too (John, 1991). Most regions, particularly developing countries are experiencing significant energy demand growth which puts pressure on global fossil fuel consumption (Okunade, 2011). Another problem that faced by energy is in developed countries existing systems and infrastructure creates resistance to adoption of renewables (MacDonald, 2011). Costs of energy from renewables are often higher than current energy prices.

Sims (2011) provides a solution to the problem by foster the growth of renewable energy technologies for example, bioenergy has a significant role to play based on views of 164 modelling groups and he also promote energy efficiency measures which is two-thirds of the world's abatement of energy-related carbon dioxide emissions will result from improving energy efficiency. For these problems, people are beginning to turn to alternative energy sources to reduce pollution while meeting their energy needs. So, in this study, it will focus more on energy efficiency and renewable energy that are used. Energy efficiency can be defined as a way of managing and restraining the growth in energy consumption. It means something is more energy efficient if it delivers more services for the same energy input, or the same services for the less energy input, (International Energy Agency, 2015). Definition for renewable energy stated by Rouse (2008) is any energy source that is naturally replenished, like that derived from solar, wind, geothermal or hydroelectric action. Energy produced from the refining of biomass is also often classified as renewable. Coal, oil or natural gas, on the other hand, are finite sources.

Although numerous studies have been made, but there are many things need to be improved. Therefore, this study attempts to explore on studies that has been conducted in renewable energy and energy efficiency. The purpose of the study is to identify and highlight the gaps in the subject matter. This study also provides an exploration to the extent of utilization of renewable energy. It explains the basic things related to energy sources, the problems encountered related to resources of energy.

LITERATURE REVIEW

Concept of renewable energy

Coal, oil and gas, which will surely be of outstanding value to future generations, as they are to ours, are however non-renewable natural resources (Abdeen, 2013a). The sunlight is not only infinite, but, moreover, it is the only energy source, which is completely non-polluting (UNFCCC, 2009). Renewable energy sources have one thing in common; they all existed before human beings appeared on this planet (Abdeen, 2013b). According to Paananen and Makinen (2013), primary energy production refers to the extraction of energy products in a useable form from natural sources, and primary energy can be produced by exploiting natural sources such as coal, crude oil or water resources or by fabricating biofuels. Ramana et al. (2012) highlight the rising concern over use of chlorofluorocarbons/ hydro chlorofluorocarbons based refrigerants and planned phase out of it have further underscored the need for promoting and wide deployment of environmentally benign renewable energy based cooling technologies.

Concept of energy efficiency

Combined heat and power is an efficient means of heat and electric power generation, regarded by scholars (Fumo *et al.*, 2009) as providing a better chance of achieving lower emissions than comparative traditional energy systems. The basic precept of combined heat and power is to recover energy generated from power and utilise it to generate heat (Nock *et al.*, 2012). The efforts for the establishment of an European Union-Gulf Cooperation Council (EU-GCC) cooperation on energy and environment, had been initiated many decades ago (Papadopoulou *et al.*, 2013). Many publicly funded programs target the commercial buildings sector which uses on-third (1,319 billion kilowatt-hours (kWh) as at 2011 (US Energy Information Administration, 2011) of all electricity produced in the USA (Horowitz, 2004). This combined with rising prices and increasing environmental awareness has encouraged pursuit of energy efficient technologies and energy efficiency programs (Ofori-Boadu *et al.*, 2015).

The types of renewable energy and energy efficiency

International Energy Agency (IEA) has summarized the technologies, existing markets and future potential markets of solar, biomass, geothermal based resources that are available for cooling applications. There have wind, wave, hydro, solar, geothermal, and tidal power are all forces of nature and are mostly intermittent energy sources, geothermal is the only consistent phenomenon (Abdeen, 2013b). News media visibility and renewable energy production are significantly correlated for wind energy and solar photovoltaic energy technologies (Paananen & Makinen, 2013). Renewable cooling refers to the cooling techniques powered by either heat and/or electricity from different sources such as solar, biomass, biogas, geothermal, hybrid, etc. Based on Cherni and Kentish (2007), in the recent years, China has initiated policy to support the development of the renewable energy industries with set targets of output from five sectors of renewable resources, namely hydro, wind, solar, geothermal and bio-mass.

According to (Abdeen, 2013a), hydrogen is now beginning to be accepted as a useful form for storing energy for reuse on, or for export off, the grid. Clean electrical power harvested from wind and wave power projects can be used to produce hydrogen by electrolysis of water. Hydropower has a valuable role as a clean and renewable source of energy in meeting a variety of vital human needs, that's mean the recognition of the role of hydropower as one of the renewable and clean energy sources and that its potential should be realised in an environmentally sustainable and socially acceptable manner. The use of wood pellets,

particularly in domestic heating solutions is one of the new, alternative ways to produce renewable energy (Heinimo, 2008). Geothermal energy is a natural resource, which can be used in conjunction with heat pumps to provide energy for heating and hot water. Carbon dioxide emissions are much lower than gas fired boilers or electric heating systems. The utilisation of wind energy (Abdeen, 2013a), as a form of energy, is becoming increasingly attractive and is being widely used for the substitution of oil-produced energy, and eventually to minimise atmospheric degradation, particularly in remote areas.

Among the various sources of renewable energy, the form that currently contributes the most is biomass (Ramana *et al.*, 2012). Biomass generally refers to crop residues, waste by-products of crop processing, wood produce of forests and woody produce of plantations grown for energy. Biogas is an environment-friendly, cheap fuel for rural areas. Biogas is derived from organic materials like cattle dung, poultry droppings, sludge, waste water, etc. With its origins in the industrial revolution, combined heat and power or cogeneration is a technology that has been available for over a century (Nock *et al.*, 2012). For instance, solar energy ventures need continuous technological innovation so as to make solar energy as a viable solution under the current technological regime of the electricity market (Ng & Nathwani, 2011). The cost of solar panels could be drastically reduced within the next generation of solar energy through technological advancement in efficiency under mass production (Dhere, 2007; Pernick & Wilder, 2010).

The benefits of renewable energy and energy efficiency

According to (Abdeen, 2013a), district heating known as community heating can be a key factor to achieve energy savings, reduce carbon dioxide emissions and at the same time provide consumers with a high-quality heat supply at a competitive price and most of the heat used for district heating can be produced by large combined heat and power plants (gas-fired combined cycle plants using natural gas, biomass, waste or biogas). Successful diffusion and adoption of renewable energy technologies are essential due to inadequate energy supply in rural areas of developing countries (Ramana *et al.*, 2012). As water is a commodity, which is finite and cannot be created, and in view of the increasing requirement as the world population grows, there is no alternative but to store water for use when it is needed (Abdeen, 2013a). Geothermal heating is more expensive to install initially, than electrical or gas-fired heating systems. However it is cheaper to run, has lower maintenance costs, and is cleaner in use than other sources of heating (Abdeen, 2013b). The major advantage of an earth energy system is that the heat obtained from the ground (via the condenser) is much greater than the electrical energy that is required to drive the various components of the system (Abdeen, 2013b).

Wireless sensor network can be used to observe the physical world at unprecedented spatial and temporal granularity and, thus, has important applications in environment monitoring, healthcare, industrial plants, homeland security, etc (Abu-Baker *et al.*,2014). Renewable energy sources provide an excellent solution to extend the lifetime of wireless sensor networks (Abu-Baker *et al.*,2014). Another benefit of using renewable energy in wireless sensor network is the removal of the potential environmental hazards caused by a large number of depleted batteries. There are numerous advantages in the use of combined heat and power; for example, it enhances the chances of achieving lower emissions than comparative traditional energy systems do (Fragaki & Andersen, 2011; Toke & Fragaki, 2008). Another advantage is its ability to run independently from centralised grid systems, thus providing users with flexibility and supply security (Kelly & Pollitt, 2010).

The functions of renewable energy and energy efficiency

Hydrogen can be used in internal combustion engines, fuel cells, turbines, cookers, gas boilers, roadside emergency lighting, traffic lights or signalling where noise and pollution can be a considerable nuisance, but where traffic and pedestrian safety cannot be compromised (Abdeen, 2013a). Heat pumps work on a similar principle to domestic refrigerators, extracting heat from one source and transferring it to another (Abdeen, 2013b). An earth energy heat pump is one of the most efficient means available to provide space heating/cooling for homes and offices, because it transfers the heat located immediately under the earth's surface (or in a body of water) into a building in winter, using the same principle as a refrigerator that extracts heat from food and rejects into a kitchen (Abdeen, 2013b). Wood pellets are small cylindrical, compressed chips of wood that are burnt in stoves and boilers in order to tackle residential heating needs (Fiedler, 2004) and which are more expensive than regular wood residues requiring extra processes and transportation (Chau, Sowlati, Sokhansaj, Preto, Melin, & Bi, 2009).

Solar cooling depends primarily on solar energy, either by hot water production through solar collectors or electricity production through photovoltaic panels. In solar electric driven cooling system, electric power produced from solar photovoltaic panels drives vapour compression refrigeration system (Ramana *et al.*, 2012). In the case of combined heat and power, however, exhaust heat is recovered and re-used, thus delivering major climatic benefits through its ability to mitigate against the emission of pollutants such as carbon dioxide, nitrogen oxide and sulphur dioxide (Torchio *et al.*, 2009). Through the capture and re-use of energy which would have dissipated into the atmosphere, combined heat and power will utilise less fuel than equivalent combustion systems to produce comparable amounts of energy (Nock *et al.*, 2012). It can thus be inferred/ posited that as an enhanced and efficient means of energy production and generation, combined heat and power can deliver critically important environmental benefits by reducing greenhouse gas emissions (Chicco & Mancarella, 2008).

RESEARCH METHODOLOGY

Data collection

The data that was collected using one source with is Emerald Group Publishing for the renewable energy and energy efficiency data for 2006 until 2015. All the articles were downloaded from the website of Emerald Insight. This website is our data source, is a database portal owned by Richard Bevan (Emerald Insight, 2015), and is widely used as a data source in scholarly research. A total of 96 articles that were analysed in this study consisted of 58 articles for energy efficiency and remaining articles is renewable energy. Table 1 shows the number of articles for energy efficiency and renewable energy based on each of the years from 2006 until 2015 that was been found in the website of Emerald Insight.

Table 1: The number of article for Energy Efficiency and Renewable Energy from 2006 until 2015

Year / Articles	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Energy Efficiency	2	1	1	2	7	4	11	11	14	5	58
Renewable Energy	-	-	6	6	2	2	6	7	4	5	38
Total	2	1	7	8	9	6	17	18	18	10	96

Source: Emerald Insight, 2015

Data analysis

The first step in the data analysis was presenting the renewable energy and energy efficiency data in line graphs to create a general view of the trends during the periods examined. Figure 1 shows the graphs for the comparison of energy efficiency and renewable energy based on the years was mention above.

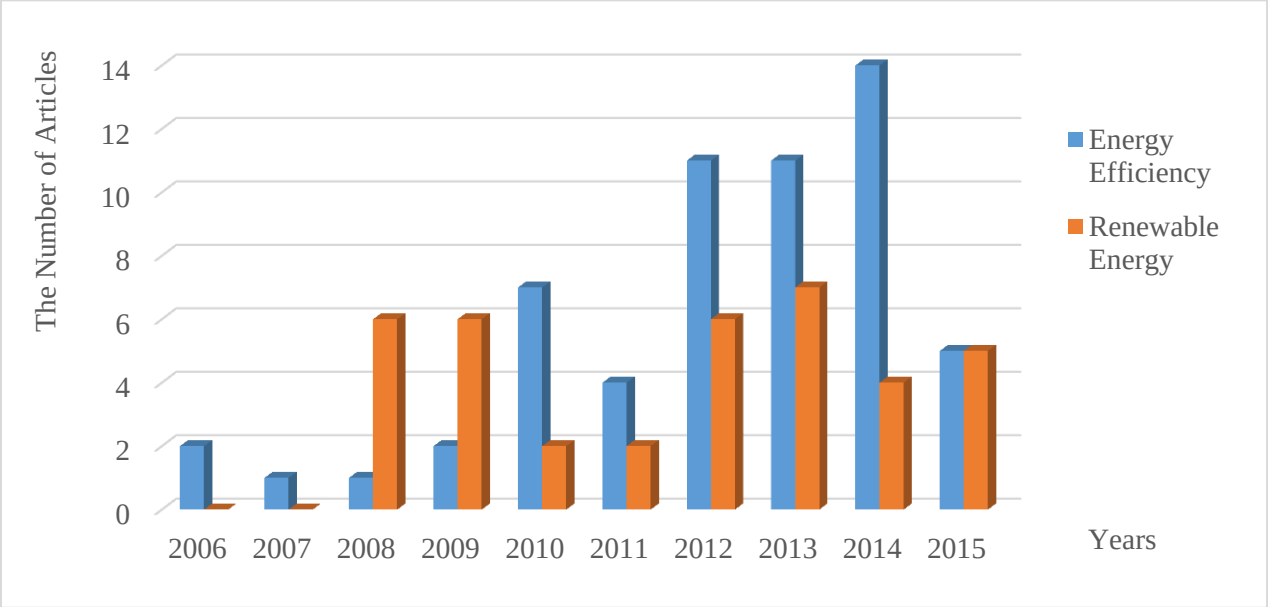

Figure 1: The number of articles for Energy Efficiency and Renewable Energy from 2006 until 2015

ANALYSIS AND FINDINGS

The Analysis by Percentage

There are 58 of the articles that related to energy efficiency rather than renewable energy refer to (Emerald Insight, 2015). With this data, it shows that many research that have been done more focus on energy efficiency compared to renewable energy. Figure 2 shows the comparison of energy efficiency and renewable energy from 2006 until 2015. It shows that energy efficiency represent 60 per cent for the total of articles and renewable energy represent only 40 per cent. From data collection in the previous chapter, we can see the higher and the

lower number of each energy efficiency and renewable energy. Between the years from 2006 until 2015, the higher number of articles for energy efficiency is 14 in 2014, meanwhile, for renewable energy, the higher number of articles is seven in 2013. The lowest number of articles for energy efficiency that have been found is only one articles which are in 2007 and 2008. However, for renewable energy shows that in 2006 and 2007 there are no research regarding on this topic.

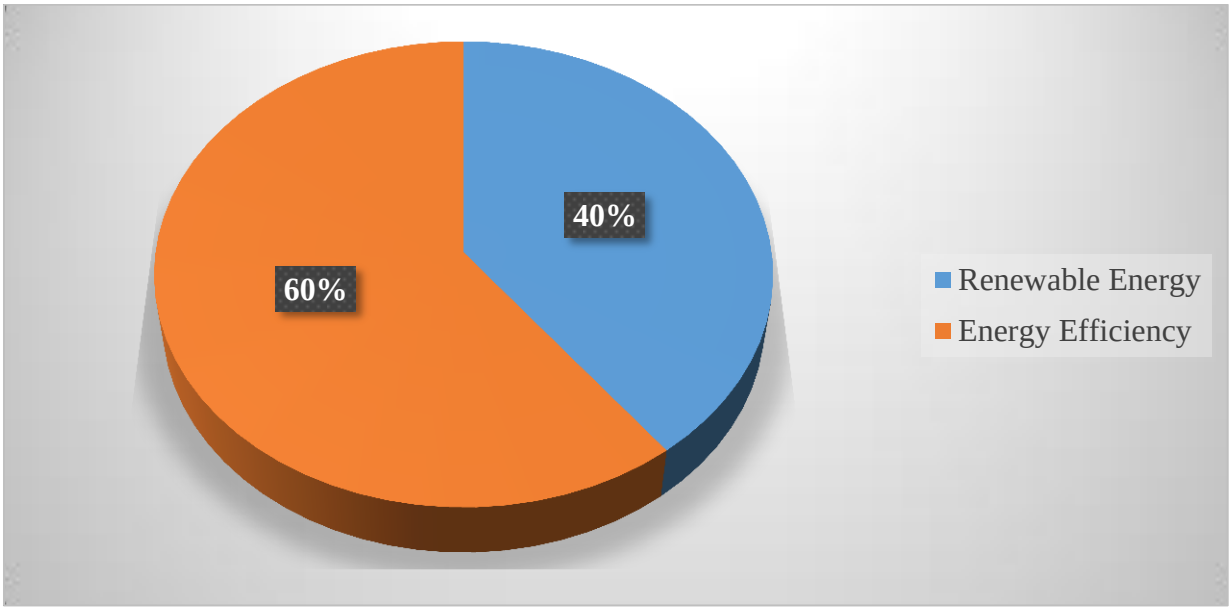

Figure 2: The Percentage of Energy Efficiency and Renewable Energy

Researchers who published their research using Emerald Insight website related to this topic was start in 2006. In 2008 until 2010, we can see that the research regarding on this topic was growing year by year which is from seven to nine articles. However, in 2011 it shows the decrease by three research. This means there were only six articles only during that year. In the next three years, there is increasing dramatically by 11 to 12 articles bringing the total to 17 in the year 2011 and 18 articles for the next two years. Finally, for 2015 only have 10 articles for the total of both renewable energy and energy efficiency.

The Analysis by Years for Energy Efficiency

From the figure 3, it shows that the percentage of articles related on energy efficiency in 2006 until 2009 only two per cent to three per cent. The percentage was increase significantly to 12 per cent in 2010. However, in 2011 the percentage of articles was decrease by five per cent. As shown from the previous table in chapter three, the number of articles for 2012 and 2013 are constant and it represent 19 per cent for both year. The highest percentage of articles in energy efficiency is 24 per cent that represent by the year of 2014. Lastly, in 2015 only nine per cent of articles regarding on energy efficiency was studied. It is drastically declined from the previous year as this project paper was done in 2015, therefore we are not fully analyse about the article that related on this topic. In the years of 2007 and 2008 show the lowest percentage of articles had been found which only two per cent meanwhile, it shows the different by 22 per cent from the lowest percentage and it make 2014 as the highest number of article that have been studied.

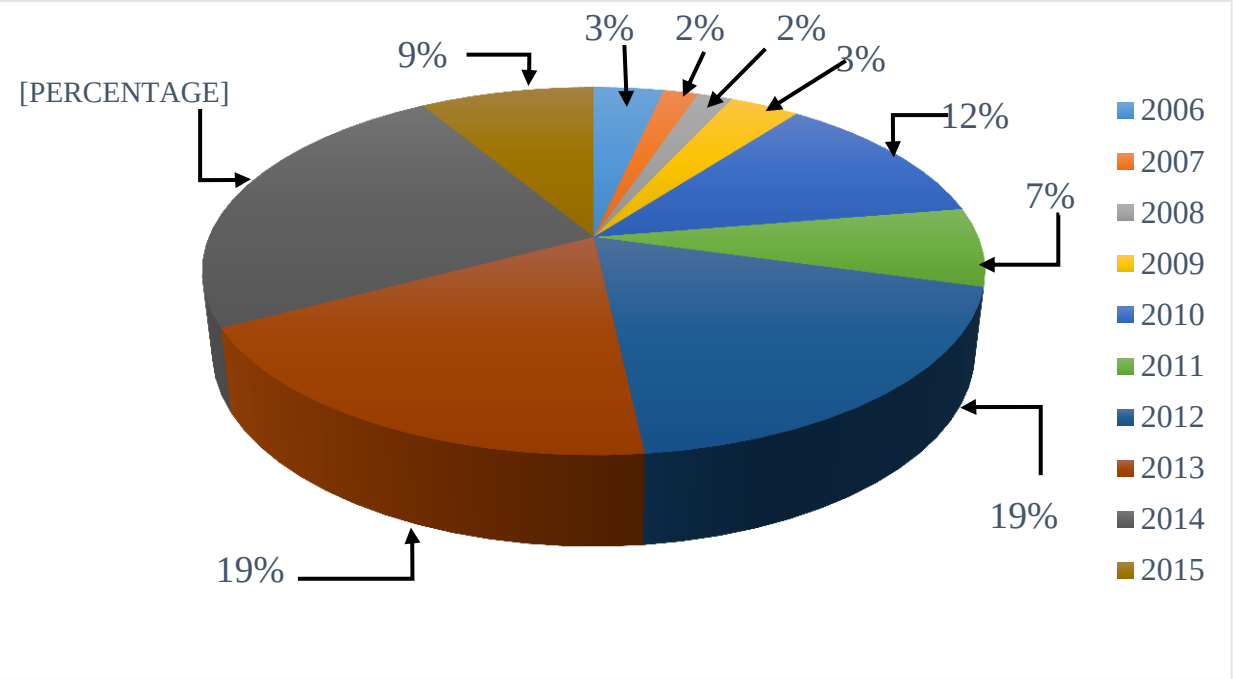

Figure 3: The Percentage of Energy Efficiency from 2006 until 2015

The Analysis by Years for Renewable Energy

Regarding on figure 4, it shows that the percentage of renewable energy from 2006 until 2015. Anyway, there have no research was done in the years 2006 and 2007. The research related to the renewable energy started in 2008, where the percentage was continued to increase to 16 per cent. In the year 2009, the same percentage as the previous year total of 16 percent. However, the percentage for the years 2010 and 2011 declined sharply by 11 per cent. This means there were only five per cent of the articles during that years. After that, the percentage of the following year rose significantly to 16 per cent. For the next year 2013, it shows that the percentage for the articles is still increasing to 18 per cent. However, in the year 2014, the percentage decreased slightly by seven per cent, which is 11 per cent.

Lastly, for the year 2015, the percentage of the articles that related on renewable energy was increased back to 13 per cent. As mention above, we know that there have no research regarding on this topic for the years 2006 and 2007, so the lowest percentage of renewable energy are in the years of 2010 and 2011. It shows only five per cent for both years. For the highest percentage was on 2013 which is 18 per cent.

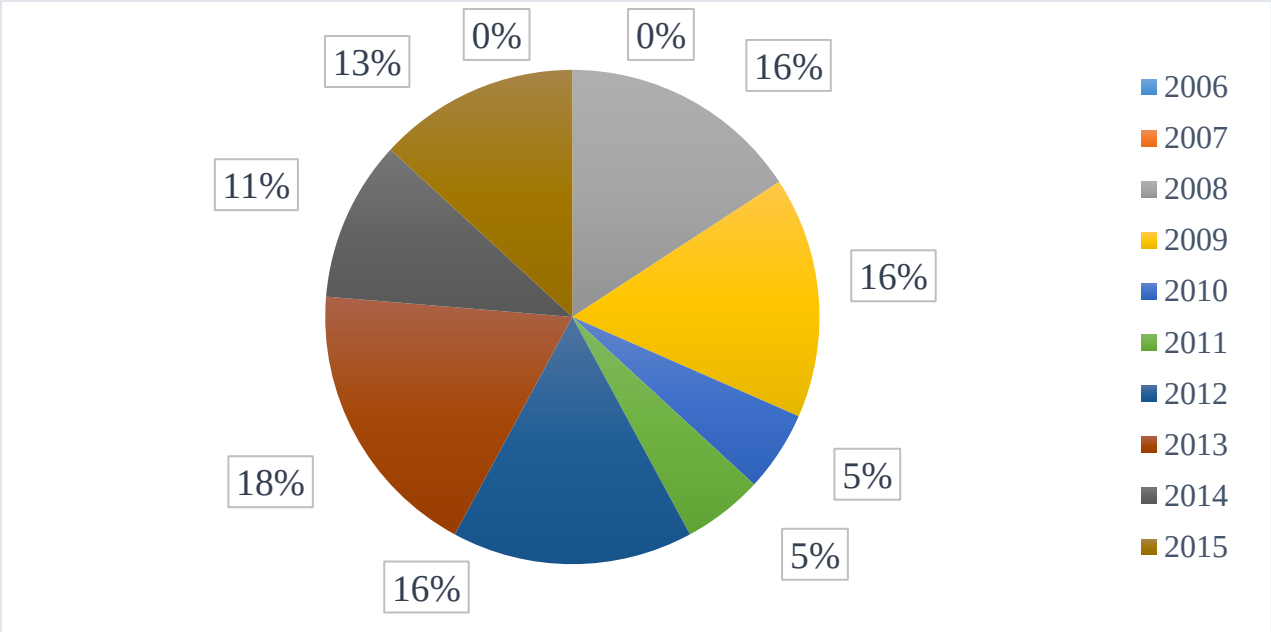

Figure 4: The Percentage of Renewable Energy from 2006 until 2015

The Number and Percentage of Continents in Energy Efficiency

Among the continents that involved are Europe, Asia, Africa, North America, South America, and Australia & Oceania. Referring to Table 2, the biggest contributor to energy efficiency consumption is the continent of Europe, where a total of 33 studies that had been done by this energy. United Kingdom is the country with the most to do research on energy efficiency, thus making European continent is the largest contributor. Besides United Kingdom, there are also other countries that have done studies on this topic, for examples in Norway, Finland, Germany, Latvia, Luxemburg, Sweden, Kosovo, Belgium, Spain, France, Ireland, Russia, Austria, Italy and Portugal. Next, for second largest contributor is continent of Asia. The total for this continent is 20 studies related on this energy efficiency. Countries that involved in this continent are China (the largest contributor), India, Qatar, United Arab Emirates, Bahrain, Kuwait, Oman, Saudi Arabia, Japan, Korea and Iran.

Table 2: The number of continents that involved in Energy Efficiency

Continents	Total	Continents	Total
Europe	33	**North America**	8
Asia	20	**South America**	3
Africa	5	**Australia & Oceania**	4

Source: Emerald Insight, 2015

In addition, the continent North America is a third continent after Asia which is eight total for the research. In North America continent, there were only two countries, namely the United States of America and Canada. United States of America is a country that being the largest contributor that represent the continent. Followed by the continent of Africa which has five total research regarding on this topic. The countries that involved are Nigeria, Morocco,

Ghana and Algeria. Next, the second smallest continent that involved in the study of energy efficiency is Australia & Oceania have a total of four research. There are two countries in this continent which is New Zealand and Australia. Lastly, the continent with the least number to do research on energy efficiency is South America that have only three total of research, and the countries that involved in this continent are Colombia and Brazil.

The Number and Percentage of Continents in Renewable Energy

In renewable energy also we will divide according to continents like Europe, Asia, Africa, North America, South America and, Australia & Oceania. According to table 3, the largest contributor that involved in renewable energy is the continent of Europe, where a total of 81 research had been done using this kind of energy. The countries that involved in this continent are United Kingdom (the largest contributor), the second largest is Germany, Spain, Finland, France, Austria, Belgium, Denmark, Greece, Italy, Ireland, Luxemburg, Netherlands, Portugal, Sweden, Latvia, Lithuania, Estonia, Malta, Poland, Slovakia, Slovenia, Czech Republic, Hungary, Cyprus, Albania, Armenia, Azerbaijan, Belarus, Bosnia & Herzegovina, Bulgaria, Kazakhstan, Romania, Russia, and Ukraine.

Next, the second largest continent involved is Asia, where the total of 44 studies related on this energy. China and India are the countries that contributed most to this continent. There are also other countries that are involved in such Philippines, Japan, Kuwait, United Arab Emirates, Taiwan, South Korea, Bahrain, Oman, Qatar, Saudi Arabia, Cambodia, Indonesia, Malaysia, Thailand, Vietnam, Tajikistan, Turkey, Turkmenistan, Uzbekistan, Bangladesh, Nepal, Pakistan, and Sri Lanka. Continents of Australia & Oceania, and Africa has the number of studies that are not much different because Australia & Oceania has 28 numbers while Africa has the number of 27 studies that have been made on renewable energy. The countries that involved in Australia & Oceania continent are Australia, Fiji, Tonga, Papua New Guinea, Solomon Islands, Samoa, Micronesia, Marshall Islands, Tuvalu, Vanuatu, Kiribati, New Zealand, Palau, and Nauru.

Table 3: The number of continents that involved in Renewable Energy

Continents	Total	Continents	Total
Europe	81	**North America**	20
Asia	44	**South America**	12
Africa	27	**Australia & Oceania**	28

Source: Emerald Insight, 2015

For the countries that were involved in continent of Africa are South Africa, Ghana, Algeria, Egypt, Morocco, Tunisia, Angola, Benin, Cameroon, Congo (Democratic Republic), Congo (Republic), Cote d'Ivoire, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Togo, Mozambique, Namibia, Sudan, Senegal, Tanzania, Zimbabwe and Zambia. The second smallest continent that contributed to the study that was made is North American continent, followed by South American continent, which is the continent with the least studies that related to renewable energy. Total number of the continent of North America is 20 studies that have been done and the countries involved, including United States of America (the largest contributor), Canada, Mexico, Honduras, Costa Rico, Cuba, Dominican Republic, El Salvador, Guatemala, Jamaica, Nicaragua, and Panama. Lastly, the total number of South America is only 12 research related

to this energy. The countries that involved in this continent are Colombia, Bolivia, Argentina, Brazil, Chile, Ecuador, Paraguay, Peru, Uruguay, and Venezuela.

CONCLUSION

From the analysis above, we can see that based on Emerald Insight many research related more on energy efficiency rather than renewable energy. Many people not really aware about renewable energy, because only 40 per cent related on renewable energy from the articles that we found in Emerald Insight. Even though, we know that renewable energy unlimited, but we still not apply it for our daily life. There are many constraints faced when preparing this study. One of them is the time that we used to complete this study is very limited. Besides that, there are other issues that this research cannot cover overall of the research regarding on renewable energy and energy efficiency. This is because we only focus on single source which is Emerald Insight website. Suggestions for improvement to future research is to collect as many as possible previous studies by topics renewable energy and energy efficiency. This is because, the data that we obtain in future more accurate. In addition, expand the source of the articles so that we will not stick with one source only. Referring to research objective, the objective of this study was achieved.

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